The benefits of engaging volunteers in urban bat research

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Abstract
The engagement of non-professionals in scientific research is referred to as 'citizen science'. Citizen science is important for answering research questions that rely on a large number of data collectors, and can be used to inform the public about scientific topics. Using the Melbourne Microbat Project as an example, we discuss the benefits of engaging the public in scientific research. The Melbourne Microbat Project included over 100 volunteers, who helped collect detailed data on urban bat populations. The involvement of volunteers in this project was a positive experience for both scientists and volunteers. We also give advice to scientists and volunteers about setting up and getting involved in a citizen science project, and provide details on two ongoing citizen science projects in which volunteers can get involved. (*The Victorian Naturalist* **130** (4) 2013, 182-187)

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Introduction

The engagement of non-professionals in scientific research is often referred to as 'citizen science' (Dickinson *et al.* 2012). Over the past 100 years, scientific organisations have increasingly included volunteers in large-scale monitoring projects to broaden the geographical extent and sample size of observations (Miller-Rushing *et al.* 2012). An early example of a citizen science project is the National Audubon Society Christmas Bird Count in the USA, which has been carried out since 1900, and provides long-term data on the population trends of birds (National Audubon Society 2013). Today, advances in technology have made it even easier for volunteers to contribute to scientific research; for example, web applications allow participants to collect large volumes of location-based ecological data and submit them electronically to centralised databases (e.g. Atlas of Living Australia; Dickinson *et al.* 2012). Citizen science can be used to tackle research questions that otherwise could not be addressed without the involvement of large numbers of data collectors (Bonney *et al.* 2009; Silvertown 2009). Many widely used ecological datasets come from citizen science programs (Miller-Rushing *et al.* 2012), as well as important baseline data (Dickinson *et al.* 2012). For example, the Indicator Bats Program (iBats), which monitors bat populations globally through volunteer microbat surveys, has provided new information on the abundance and distribution of microbats worldwide (The Indicator Bats Program 2013). Similarly, the National Bat Monitoring Programme, which has involved over 3500 volunteers since 1996, has provided essential information on the population trends and habitat requirements of microbats across the United Kingdom (Bat Conservation Trust 2013). Citizen science also can be used as a method of engaging the public in the scientific process with the goal of improving scientific literacy (Bonney *et al.* 2009; Silvertown 2009), and to inform participants about particular scientific topics (e.g. climate change; Lowman *et al.* 2009). Additionally, citizen science projects can provide a connection between people and nature, which is essential for generating broad-based public support for biodiversity conservation, and to enhance human well-being (Miller 2005).

This article discusses the benefits of engaging volunteers in scientific research (using the Melbourne Microbat Project as a case study) from the volunteer and scientist perspectives. We present findings from the Melbourne Microbat Project, to show what can be achieved by involving volunteers in scientific research. We also give advice to scientists on what should be considered when setting up a citizen science project, and to volunteers on how to choose a project. Finally, we provide information on two ongoing bat projects in Melbourne in which volunteers can get involved.

Case study: Melbourne Microbat Project

Insectivorous microbats (hereafter bats; Fig. 1) belong to the second largest order of mammals (Chiroptera) and occur in all continents

Fig. 1. The Lesser Long-eared Bat *Nyctophilus geoffroyi*, one of the 16 insectivorous microbat species found in Greater Melbourne. Photo Lindy Lumsden.

across the world except Antarctica (Kunz and Fenton 2003). Bats are a major contributor to mammalian biodiversity and provide essential ecosystems services. For example, bats play an important role in suppressing pest insects (e.g. agricultural pests and mosquitoes; Kunz *et al.* 2011; Gonsalves *et al.* 2013). Bats are one of the few native mammals still persisting in urban environments (van der Ree and McCarthy 2005). There are 16 species of bats in Greater Melbourne (van der Ree and McCarthy 2005). Bats have been recorded in backyards across Melbourne, including within the inner city suburbs of Preston, Carlton and Essendon. A number of studies (Vaughan *et al.* 1997; Gaisler *et al.* 1998; Threlfall *et al.* 2011) have shown that bats are sensitive to urbanisation, where bat activity and species diversity are lower in highly urbanised areas. The negative influence of urbanisation on bats is likely due to the loss of foraging and roosting habitat. Many Australian bat species depend on hollow bearing trees, the density of which have declined from 13-22 ha^{-1} to 5.8 ha^{-1} within urban bushland remnants in Melbourne (Harper *et al.* 2005), and which is significantly lower (0.08 ha^{-1}) within residential areas (Shukuroglou and McCarthy 2006). Melbourne, which has a population of 4.1 million, is Australia's fastest growing capital city, with up to an additional 1 million people anticipated by 2030 (Department of Planning and Community Development 2013). As Melbourne continues to grow, it is essential that the requirements of bats are quantified so that we can better manage their habitat and ensure their persistence in urban areas; however, at present, there is very little information on the ecology of Melbourne's bats.

The Melbourne Microbat Project started in 2009 with the objective to describe the distribution and habitat preferences of bats within the city of Melbourne, Australia. The Melbourne Microbat Project is a collaboration between the Australian Research Centre for Urban Ecology (ARCUE), the University of Melbourne, numerous industry partners and with funding from the Australian Research Council. The researchers on the project (from ARCUE) include a postdoctoral research fellow and two PhD students. The Melbourne Microbat Project has three broad components, including: distribution and habitat modelling, population viability analyses, and a study on the roosting and foraging requirements of bats. This article will focus on the roosting and foraging component of the Melbourne Microbat Project. The main aims of the roosting and foraging component were to determine the prey availability (nocturnal aerial insects) for bats in Melbourne, and identify important habitat types for providing prey; and to investigate the types of roost trees used by bats in Melbourne's parks and reserves, and the influence of urbanisation on roosting behaviour.

Methods

To obtain meaningful results on the foraging and roosting requirements of bats, we needed large, detailed data-sets. As a result, the data collection process was highly labour intensive. For example, to measure bat prey availability, we needed to set up 120 insect traps (light traps) and bat detectors (a small unit which records bat echolocation calls) across Melbourne, we also needed to sort and identify over 70 000 insects, and perform detailed assessments of more than 1 km^2 of vegetation. Further, to investigate the roosting ecology of Melbourne's bats we needed to set up 400 harp traps (over 40 nights), radio-track 120 bats across three field sites in south-east Melbourne (Royal Botanic Gardens Melbourne, Blackburn Lake, and Valley Reserve), and assess more than 2 km^2 of vegetation.

The involvement of volunteers

The volunteers in this project were from Earthwatch Institute Australia. Earthwatch is a not-for-profit organisation which facilitates the involvement of the public in scientific research projects. Earthwatch, along with state and local government, is one of the Industry Partners which provided support to the Melbourne Microbat Project. Earthwatch contributed to the Melbourne Microbat Project by providing volunteers to assist with field and lab work. These volunteers were part of two Earthwatch programs: Scientist for a day and Student challenge. Scientist for a day was an overnight program which involved members of the general public, families, and corporate groups. Student challenge was a week-long program designed for high school students aged 16–17 years. Both programs included 6–8 volunteers per session, and from 2009 to 2012 a total of 108 Earthwatch volunteers (28 for Student challenge, 90 for Scientist for a day) were involved with the Melbourne Microbat Project. Tasks carried out by Earthwatch volunteers included:

- Setting up harp traps (see back cover)
- Recording data (weight, measurements, etc.) from captured bats*
- Counting and measuring trees and shrubs
- Helping to radio-track bats (Fig. 2)
- Carrying out stag watches (observing bats emerge from roosts at dusk)
- Sorting and identifying insects

*Note – Only volunteers who are trained in bat handling and have current vaccinations against Australian Bat Lyssavirus can handle the bats directly and take measurements.

The involvement of 'citizen scientists' made it possible to run a large-scale project on urban bats. With the help of volunteers, the Melbourne Microbat Project was more efficient in terms of cost and time. For example, to set up 400 harp traps it would take 170 hours with two people, 100 hours with Scientist for a day teams, and 40 hours with Student challenge teams. The Student challenge teams were generally more efficient at setting up harp traps as they were able to master skills throughout the week-long program.

The benefits of involving volunteers in the Melbourne Microbat Project

From the volunteer perspective

Volunteers were valued members of the research team. They set up field equipment and collected ecological data, while being able to discuss the research and wider conservation issues with scientists. Volunteers also experienced something unique, seeing animals they had not realised existed in Melbourne, and accessing areas that are normally off limits to the public (i.e. the Royal Botanic Gardens in Melbourne and Cranbourne after dark). Volunteers also gained an understanding of the issues facing bats in urban areas and their importance in urban ecosystems (i.e. controlling pest insects, and contributing to mammalian biodiversity). Students in the week-long programs enjoyed the opportunity to master new skills and develop friendships with their teammates. We also found that volunteers still learnt something even when the weather was inclement or no bats were caught. They gained an understanding that field-based research doesn't always run smoothly, and developed an appreciation of the effort involved in collecting ecological data.

Feedback from Earthwatch volunteers involved in the Melbourne Microbat Project included the following comments:

> 'Fun and informative. Really enjoyed this unique experience.' Bridie – Scientist for a day.

> 'I now have a new appreciation of bats.' Jason – Scientist for a day.

> 'It has made me want, even more so, to pursue a career within science.' Maddy – Student challenge.

From the scientist perspective

The involvement of volunteers enabled us to capture and gather data on large numbers of bats and efficiently survey environmental variables such as vegetation structure and insect prey abundance. Having a team of willing research assistants also made logistically impossible tasks possible (i.e. simultaneously collecting extensive data from different field sites across Melbourne). Involving volunteers with diverse

backgrounds also provided new perspectives and input into our research goals and methods. Additionally, directly involving volunteers in scientific research was a great way to create awareness about bats and deliver messages on conservation to the public while, at the same time, carrying out significant research to help conserve bats in our urban landscape.

Findings from the Melbourne Microbat Project

With the help of over 100 volunteers, we were able to collect meaningful information on the foraging and roosting requirements of Melbourne's bats. Some of our results included:

- In Melbourne's parks and reserves, bats roosted within the trunks and branches of small-diameter (30 cm) dead trees, and under the dead fronds of palm trees. Bats showed a preference for these roost types during breeding and non-breeding seasons. The protection and provision of these roost types will benefit urban bat populations.
- Remnant bushland reserves and well-treed riparian areas are important foraging zones for urban bats; residential backyards also provided a greater abundance of prey than expected.
- Providing more trees and greater understorey will promote more insects and provide greater foraging opportunities for bats.

This information is essential for developing conservation plans and guidelines for land managers (how to effectively manage roosting and foraging habitat for bats) and for facilitating future research, which will help to minimise the negative effects of urbanisation on bats and ensure their continued presence in Melbourne and other cities worldwide.

Recommendations for scientists and volunteers

Scientists: how to involve the public in your research programs

When designing and setting up a citizen science project there are a few things to consider. Firstly, think carefully about the number of volunteers required, what tasks they will be doing, and the skills they will need to learn. Consider how long volunteers will need to participate in the project. If your project involves complex tasks, where volunteers will need to be trained, it will be less efficient to employ a short-term volunteer. To help things run smoothly, develop clear instructions and structured activities with explicit goals. Inform volunteers of the schedule of field or lab activities at the start of each day, so they know what is required of them. Be aware that, if large numbers of volunteers are collecting data, data integrity may be compromised. However, careful planning and data quality checks (i.e. comparing to other data-sets to identify outliers, having research staff enter data and perform checks), can ensure consistent, quality data are collected. Having a regular, knowledgeable core of long-term volunteers also helps to ensure data quality. Make sure the experience is enjoyable for volunteers if they are helping out for more than a few hours; offer other activities during work breaks (i.e. a presentation or an open discussion about the research project, conservation-themed trivia, nature walks). Lastly, motivate volunteers through acknowledging their efforts and informing them of your findings so they can see the significance of their contributions. Feedback and communication with volunteers is particularly important for ongoing projects that need to attract ongoing volunteers in order to be viable.

Volunteers: how to get involved in science research programs

There are a wide range of long-term (i.e. on a regular weekly or monthly basis) and short-term (i.e. over a weekend) citizen science projects to get involved in, including the two projects listed at the end of this article, and through organisations such as Earthwatch Institute Australia and the Field Naturalist's Club of Victoria. When investigating citizen science projects, read project descriptions carefully and ask questions to help assess whether the volunteer role would be suitable for you. Be aware that some projects can involve long work days,

overnight work, or working in sometimes unfavourable conditions (i.e. in hot or humid environments). While you are volunteering for a citizen science project, ask questions or participate in discussions with the scientists leading the project; this is an excellent chance to learn something new, and also to contribute to science through your own observations.

Other citizen science projects with bats in Melbourne

Here we present examples of two ongoing citizen science research projects in Melbourne: the Flying-fox count at Yarra Bend and the Wilson Reserve microbat roost-box project. Both projects run throughout the year and new volunteers are always encouraged to get involved.

Flying-fox count at Yarra Bend, Kew

The Grey-headed Flying-fox *Pteropus poliocephalus* resides in a 'camp' at Yarra Bend, Kew. Since 2003, monthly fly-out counts (counting flying-foxes as they leave the camp at dusk) have been carried out by volunteers to determine the population size of flying-foxes at Yarra Bend. The number of flying-foxes within the camp varies seasonally and annually, and can reach up to 40 000 over the summer months. Information on population size and distribution is essential for the management of flying-fox populations. New counters are welcome at the fly-out count, and training is provided on the night. To find out more about this project go to http://arcue.botany.unimelb.edu.au.

The Wilson Reserve microbat roost-box project, Ivanhoe

This project involves the monthly monitoring of bat roost boxes, which have been set up at Wilson Reserve, Ivanhoe, since 2005. This project is run entirely by volunteers, and have included scientists, students and members of the public. The aim of this project is to investigate roost-box usage, and to carry out a bat-banding program to gather information on population dynamics and life history. Tasks carried out by volunteers include: taking measurements of bats (for those who are trained in bat handling and have current Australian Bat Lyssavirus vac-

Fig. 2. A group of volunteers using radio-telemetry to track a Gould's wattled bat *Chalinolobus gouldii* to its roost. Photo Earthwatch.

cinations), carrying and stabilising the ladder, carrying the bats in cloth holding-bags, recording data on box contents, and animal measurements. Several volunteers have become experienced and competent bat-handlers as a result of their participation in this project. The Wilson Reserve roost-box project is carried out one Saturday afternoon per month, and new volunteers are always welcome. Volunteers can also help monitor roost-boxes at the nearby Burke Road Billabong, Kew, which are checked on the same day. A similar and longer-term project at Organ Pipes National Park in Sydenham, conducted since late 1994, has also involved many volunteers, some of whom have become long-term contributors to the monitoring project. To find out more about these projects go to: http://portphillipwesternport.landcarevic.net.au/fo-wilson-reserve (for Wilson Reserve) and http://home.vicnet.net.au/~foopnp/ (for Organ Pipes National Park).

Conclusions

We found that engaging volunteers in the Melbourne Microbat Project was beneficial for both the volunteer and the scientist. Volunteers learned new skills, experienced something unique (i.e. seeing a bat up close) and developed an appreciation for the data collection process. For scientists, it was possible to collect a large and valuable data-set, while at the same time raising awareness about bat conservation issues. Overall, with appropriate planning, citizen scientist projects can provide scientific data that can be used to develop conservation guidelines and improve scientific literature, while fostering links between the scientific community and the general public to promote the importance of valuing biodiversity.

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